Responding to global change

a theory of change approach to making agricultural research for development outcome-based

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Perspectives

Responding to global change: A theory of change approach to making agricultural research for development outcome-based

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ABSTRACT

Agricultural research for development has made important contributions to poverty reduction and food security over the last 40 years. Nevertheless, it is likely that both the speed of global change and its impacts on natural and socio-economic systems are being under-estimated. Coupled with the moral imperative to justify the use of public resources for which there are multiple, competing claims, research for development needs to become more effective and efficient in terms of contributing towards longer-term development goals. Currently there is considerable debate about the ways in which this may be achieved. Here we describe an approach based on theory of change. This includes a monitoring, evaluation and learning system that combines indicators of progress in research along with indicators of change aimed at understanding the factors that enable or inhibit the behavioural changes that can bring about development impacts. Theory of change represents our best understanding of how engagement and learning can enable change as well as how progress towards outcomes might be measured. We describe the application of this approach and highlight some key lessons learned. Although robust evidence is currently lacking, a theory of change approach appears to have considerable potential to achieve impacts that balance the drive to generate new knowledge in agricultural research with the priorities and urgency of the users and beneficiaries of research results, helping to bridge the gap between knowledge generation and development outcomes.

1. Introduction

The last 25 years have seen substantial improvements in human wellbeing. Between 1990–92 and 2012–14, there was a 42% reduction in the prevalence of undernourished people in developing regions (FAO, 2015). Considerable regional differences exist in the progress that has been made against poverty and hunger in the time span, however: in South Asia progress has been limited, and in sub-Saharan Africa the situation regarding poverty and hunger has become worse (FAO, 2015). There were still 805 million people who were chronically undernourished in 2012–2014 (FAO, 2015), almost all in developing countries. Clearly, there is much to be done to reach the targets for 2030 as articulated in the Sustainable Development Goals (UN, 2015), particularly Goal 2 on ending hunger, achieving food security and improved nutrition and promoting sustainable agriculture. With an expected extra 2–3 billion people to feed over the next 40 years, this will require targeted efforts to achieve making 70% more food available to keep up with rapidly rising demand (Alexandratos and Bruinsma, 2012). At the same time, climate change is already affecting agriculture in many developing countries, and the effects will become increasingly challenging in the future (Thornton et al., 2014a).

Several approaches are being used to address poverty, and in developing countries agricultural development is one. The role of agriculture in reducing poverty is relatively well studied; enhancing agriculture is often seen as a critical entry-point in designing effective poverty reduction strategies (Christiaensen et al., 2006; Alston, 2010), with agricultural research for development (AR4D) a key mechanism. The adoption of improved agricultural practices, technologies and policies, such as high-yielding rice and wheat varieties, fertilizers, pesticides, irrigation and enabling policies, has had strong and positive impacts relative to research investment (Renkow and Byerlee, 2010; Raitzer and Kelley, 2008). Nevertheless, the world food system continues to face challenges of persistent food insecurity and rural poverty in places. The adoption of improved agricultural technologies and practices by farmers has often been less than expected, despite demonstrated benefits. There are many contributing factors, including inherent limitations of supply-led approaches to development and dissemination, limited attention to context-specificity and to farmers' priorities beyond increased agricultural productivity, and lack of appreciation of the socio-

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economic, political and institutional contexts within which smallholder farmers operate (Orr, 2012). A technology or intervention may need to be much more than "scientifically proven" if it is to be adopted; good social management and appropriate implementation processes are likely to be needed as well (Pachico and Fujisaka, 2004; Hartmann and Linn, 2008). In addition, the rate of change in many socio-economic and earth system trends appears to be accelerating (Steffen et al., 2015), perhaps to the point where the past is no longer a good indicator of the future. Considerable behavioural shifts will be needed on the part of all stakeholders if food security is to be achieved for the more than 9 billion people on the planet by 2050.

AR4D has huge challenges ahead, and ways are needed to do it more effectively and efficiently. Here we outline one approach to AR4D that may have some potential for addressing issues of effectiveness and efficiency – an approach based on theory of change and impact pathway thinking. This approach is illustrated with reference to the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), a global partnership that unites organisations engaged in research and capacity development for a food secure future. This is among the first examples of a large AR4D program being orientated this way. Although we are not yet at the stage of being able to carry out a robust evaluation of CCAFS with respect to the effectiveness of a theory of change approach, its implementation to date has generated important lessons that we believe can enhance its effectiveness at scale. In the next section, we provide some background on theory of change. In Section 3 we discuss progress so far in implementing the approach in CCAFS, focusing on program design and systems for planning and reporting. We conclude with a discussion of some of the lessons learnt regarding institutional change, monitoring and evaluation, and behavioural change.

2. Background

AR4D can be thought of as a set of applied research approaches that aim to contribute directly to the achievement of international development targets such as the Sustainable Development Goals (UN, 2015) through growth of and innovation in the agricultural sector. This broad definition allows for a wide understanding of the concept. In what follows, we assume that the research element of AR4D is carried out with broader development outcomes in mind, and that this involves demand-led prioritization of research, participatory and action research, and stakeholder involvement and capacity development (Harrington and Fisher, 2014).

Over the last 40 years, agricultural research has undergone several different "framings" regarding the role of research and its effect upon the world, but current ideas generally crystallise around a logical sequence of events as shown in Fig. 1, though recognising that this is never a linear process. Resources are utilised in a set of research activities, which produce research outputs that are then used. The use of these outputs contributes to behavioural changes, manifested in changes in knowledge, attitudes, skills and practices of a wide set of non-research next users such as development practitioners, extension services, farmers and policy makers. These outcomes in turn lead to impact, such as increased food security or reduced poverty. Fig. 1 is no more than a caricature of these processes, but it illustrates that while research focuses mostly on producing research outputs and development on producing outcomes and impact, AR4D is an attempt to bridge the two. Some of the key characteristics of agricultural research, development and AR4D are listed in Table 1. The boundaries of these realms are necessarily fuzzy, and the characteristics related to evaluation and timeframes in particular are somewhat idealised and may not reflect current practice in use-orientated research (Nowotny et al., 2003). Nevertheless, the distinctions are important; the aim of AR4D is not to take over the work of development agencies but to ensure that the outputs of research maintain their integrity and are appropriately contextualized (translated, communicated, and disseminated). Working in this way at the boundaries of science, knowledge and action means that different kinds of partnership are needed if AR4D is to be effective (Clark et al., 2011). AR4D has to tread a careful line between the "R" and the "D". On the one side, research is a risky business, its results uncertain, and its application sometimes very far from obvious (for instance, the development of quantum physics and computers in the early and mid-twentieth century, respectively – daily life now is unimaginable without them). On the other side, the nature of development is very different to that of research, involving different aims, skills, partners, and time frames.

The different framings of agricultural research in a development context have been driven largely by development agencies and funding agencies. Such organisations often face common challenges: how to strengthen their accountability for the use of public resources, how to deal with analytical issues of attributing impacts and aggregating results, how to establish effective performance measurement systems, how to ensure a distinct yet complementary role for evaluation, and how to establish organisational incentives and processes to stimulate the use of performance information in management decision-making (Binnendijk, 2000). Often, such organisations have been instrumental in implementing new or modified approaches to AR4D.

Canada's International Development Research Centre (IDRC) made early efforts to articulate how AR4D could contribute to desired behavioural changes or outcomes (Earl et al., 2001). This articulation revolves around defining in some detail, during project planning, how the project team envisages the logical chain of Fig. 1 to unfold in practice. The resulting theory of change represents the team's best understanding or hypothesis, at that point in time, of how engagement and other approaches can bridge the gap between research outputs and outcomes in development. There is no single definition of a theory of change and no set methodology; rather, the approach allows flexibility according to the needs of the user or implementer (Vogel, 2012). A theory of change provides a detailed narrative description of an impact pathway (the logical causal chain from input to impact as shown in Fig. 1) and how changes are anticipated to happen, based on assumptions made by the people who are undertaking the work. (While theories of change

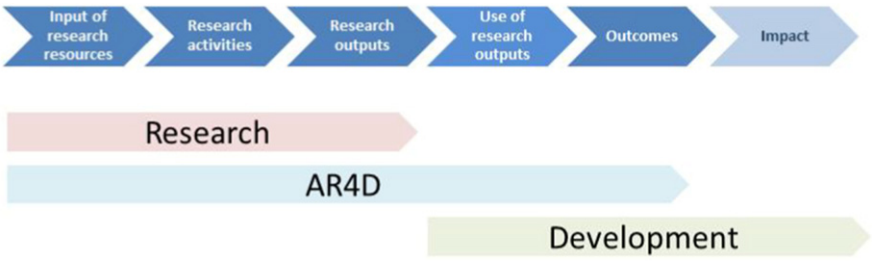

Fig. 1. A logical causal chain from research inputs to impact, and the domains of research, development, and agricultural research for development (AR4D). This is highly simplified from what may be a complex, iterative process.

Table 1
Comparison between agricultural research, agricultural research for development (AR4D) and international development.
(Adapted from Schuetz et al., 2016.)

Characteristic	Research	AR4D	International Development
Organisation of activity	Research centres with a key scientific focus	Interdisciplinary research programs built around a development challenge and partnership approach	NGOs, development aid agencies, UN agencies
Mandate and performance focus	Outputs	Outcomes	Impacts
Mechanism for achieving impact	Provision of solid science knowledge and technologies	Strong partnerships incorporated within the research program	Implementation
Type of communication, knowledge management	One-directional communication	Communications for development (based on research), engagement as part of the research process	Communications for development, engagement
Type of partners	International, regional, national research partners	International and national research partners, and development agencies	Local/district implementing agencies, central/national governments
Program evaluation	Traditionally focused on quantitative measures: number of publications, quality of journals, number of citations	Learning-based approaches dealing with contribution rather than attribution, balancing quantitative with qualitative measures, assessment of outcomes achieved	Focused on traditional impact assessment and quantitative measurements building on baselines
Timeframe for achieving outcomes/impact	Traditionally, outcomes/impact often not considered; much research may never achieve these	Achieving outcomes at scale within 5 years and impact within 15 years	Long-term impacts at large scale in 10–20 years, at local scale in a few months
Languages of products	International standards	Both international and locally appropriate languages	Both international and locally appropriate languages

may describe a range of different processes and mechanisms, those based on the direct use of research outputs (as in Fig. 1) are likely to be appropriate for many A4RD programs and projects; such "use-oriented" theories of change are the subject of the work reported here.) Vogel (2012) traces theory of change to the development of program theory approaches in the 1960s. These approaches, built on theoretical underpinnings, revolve around clear articulation of the linkages between inputs and outcomes, and the assumptions that accompany these linkages, with the aim of improving evaluation and program performance (Funnell and Rogers, 2011). Theories of change can thus provide a means to make explicit the implicit, often elusive, hypotheses on the processes that bridge the gaps between research design, outputs, use, and outcomes (Fig. 1).

Logical Framework Analysis (LFA) originated at USAID in the early 1970s before spreading to UNDP and beyond (Bell, 2000). LFA has been widely used over the last 30 years for project planning; indeed, it has often been an integral part of applications for funding. LFA has been widely criticised for being overly prescriptive: it adheres to a relatively rigid framework, with a hierarchy of objectives converging on a single goal, a set of measurable and time-bound indicators of achievement, checkable sources of information, and assumptions of other impinging factors (Gasper, 2000). A substantial literature exists on the advantages and weaknesses of LFA (e.g., Bakewell and Garbutt, 2005; Vogel, 2012). Despite the fact that LFA has been a mainstay of project planning for several decades, some questions have been raised as to its overall suitability as an approach for ensuring the use of research results and their translation into outcomes (Crawford and Bryce, 2003). Perhaps its major failings are that LFA does not pay enough attention to involving key stakeholders and their networks to achieve impact, providing managers with information to learn and report to funding agencies, and establishing a research framework to examine the change processes that projects seek to initiate (Douthwaite et al., 2008; Vogel, 2012).

Theory of change approaches can help to address these drawbacks of LFA, because of their explicit focus on all the key participants in the process of AR4D, and because the research framework and hypotheses that are developed in a particular project lend themselves readily to monitoring and evaluation, and to being changed or reformulated if found wanting. Perhaps more fundamentally, approaches based on theory of change can address the well-documented need for learning as a (perhaps the) critical element of innovation in complex systems (Douthwaite et al., 2003; Jordan and Warner, 2010; Klerkx et al., 2010). This is the main reason why approaches based on theory of change hold out such promise, even if robust evidence for their effectiveness in delivering desired outcomes and impact is still in the process of being generated – and not just in the agricultural development arena (Jackson, 2013). Theory of change approaches are no panacea: Valters (2014) notes that while such approaches can be used to communicate, to learn and to be held accountable, these will often exist with some tension between them, particularly the accountability element. Nevertheless, theory of change approaches can help facilitate the broad commitment to learning from individuals and organisations that is increasingly being seen as an essential element of sustainable development (Pahl-Wostl, 2009; Vogel, 2012; Kristjanson et al., 2014; Valters, 2015).

Approaches based on theory of change have several implications for implementation in practice. These include the necessity for qualitative as well as quantitative monitoring of the performance of research projects (Springer-Heinze et al., 2003; Young and Mendizabal, 2009), the need to formalise a project's theory of change by involving a wide range of people in its design (Chen, 2005), and regularly examining the assumptions associated with it and adjusting program management accordingly (Douthwaite et al., 2013). A major challenge is how to evaluate projects appropriately. In the last 15 years, many development agencies and funding agencies have developed evaluation systems that are based on metrics of performance: so-called results-based management (RBM), by which is meant a life-cycle approach to management in which actors seek to ensure that their actions contribute to the achievement of desired results by iteratively using actual results to inform future actions (Mayne, 2007a, 2007b; Bester, 2012). RBM can build on the same logical causal chain (Fig. 1) and can force more explicit thinking about output use: strategies that directly engage next-users in the research process, for instance through stakeholder platforms and user-oriented communication products. There is considerable debate as to whether RBM leads to efficiency and effectiveness gains in AR4D compared with other evaluation mechanisms. We touch on these issues below, although here our focus is primarily on the theory of change approach itself, rather than on RBM as a method of evaluation. Before that, Section 3 describes the design and implementation of a particular research management approach to AR4D based on theory of change, in relation to the processes themselves; learnings from these processes are discussed in Section 4.

3. Implementing a theory-of-change based approach to AR4D: CCAFS as a case study

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is made up of the 15 international agricultural research centres of CGIAR, integrating thematic work across multiple global, regional and local partners. The goal of CCAFS is to overcome the additional threats posed by a changing climate to achieving food security, enhancing livelihoods and improving environmental management. The program works to identify and test pro-poor adaptation and mitigation practices, technologies and policies for food systems, adaptive capacity and rural livelihoods, and to provide diagnosis and analysis that will ensure cost-effective investments, the inclusion of agriculture in climate change policies, and the inclusion of climate issues in agricultural policies, from the sub-national to the global level in ways that bring benefits to the rural poor (Vermeulen et al., 2012; Förch et al., 2014).

CCAFS started in 2010 with research activities clustered into six (later four) thematic areas, working in three regions: East Africa, West Africa, and South Asia. Initially, CCAFS was required to use LFA to plan and monitor project activities across its portfolio. In 2013, the scope of CCAFS expanded to include two new target regions, Southeast Asia and Latin America. At the same time, opportunities arose because of changes in CGIAR to implement and test a theory of change approach, with a greatly-expanded set of partners and longer-term objectives. This was done as a pilot, involving six new, multiannual projects that were set up via a competitive process (Thornton et al., 2014b); it was envisaged that the approach would be extended to the entire project portfolio in subsequent years. At the time, these projects accounted for approximately 7% of CCAFS' portfolio, in terms of both total budget and the number of projects (US$ 3.7 million in six projects). These new pilot activities were tasked with designing their projects using a theory of change approach, which included not just planning research outputs but also planning for outcomes.

3.1. Building capacity and learning within the program for a theory of change approach

The CCAFS pilot project teams were thrown in at the deep end. Used to a more traditional LFA, they were tasked with shifting to a theory of change and learning-based approach for planning their projects within the trial. It was quickly apparent that capacity to plan and implement projects using this new approach had to be built within CCAFS and its partners.

Using theory of change approaches within AR4D requires the strengthening of scientists' capacities to do research differently, work across research disciplines, and work with non-research partners for impact, and that institutions facilitate such shifts. Several authors highlight the importance of building capacity for institutional learning (Hall et al., 2003; Horton and Mackay, 2003; Eade, 1997; Springer-Heinze et al., 2003). Johnson et al. (2003) show that participation of non-research stakeholders early on in the research process is important, as it can inform institutional learning in research organisations to change priorities and practices. It can also enhance the relevance of agricultural technologies and the capacity of these stakeholders to design their own action research processes. Horton and Mackay (2003) outline the links between monitoring and evaluation (M&E), learning and institutional change and highlight the importance of institutional learning as a means to develop the capacities of the organisation and of individual researchers, and empowering non-research partners as key stakeholders in the process.

CCAFS implemented a one-week training course on using theory of change for project and program planning (Alvarez et al., 2014). Participants were chosen strategically so that capacity would be available in CGIAR Centres at the time when proposals would need to be developed following theory of change principles. In addition to project representatives, several CCAFS scientists participated, so that in-house capacity was built. The training, in combination with theory of change facilitation guides (Jost et al., 2014; Schuetz et al., 2014a) and learning notes (listed in Annex 1) helped highlight the opportunities and constraints of rolling out a theory of change approach to an entire AR4D program. An online community of practice and wiki were established, so that experiences could be documented and shared during the pilot phase.

3.2. Insights from researchers and partners during the pilot phase

CCAFS's approach to theory of change is centred on adaptive management, regular communications between program and projects, and facilitated learning within and between projects. Besides periodic virtual meetings, project participants in the pilot phase were surveyed for a more in-depth and standardised reflection, and for capturing lessons and achievements from their experiences. These lessons, from both a project and programmatic perspective, were documented in reports and a series of learning notes (see Annex 1). The approach to developing theories of change was simplified over time, mostly by reducing the type and number of indicators and the level of complexity so that the wider group of people who were expected to work with them would continue to buy into the approach. This simplification led to a heavily revised version of the training and facilitation guide (version 1: Jost et al., 2014; version 2: Schuetz et al., 2014a).

Many project participants and partners were willing to take on the challenge to develop new ways of collaborating and working beyond delivering outputs. After one year of the pilot phase, several projects had made considerable progress, although making fundamental shifts in the way of working takes time and (initially at least) additional resources, as well as iteration and learning. It also may affect team composition. Some projects recognised that additional skills beyond disciplinary expertise would be required, such as skills in coordination, facilitation, engagement, communications, and participatory and learning-oriented monitoring and evaluation. Stakeholder buy-in and a supportive organisational environment were also seen by most projects as necessary elements in implementing the approach.

3.3. Rolling out the approach for CCAFS as a whole

Opportunities for changing the programmatic approach to project planning and implementation emerged towards the end of 2014, largely in response to a desire to refine the project portfolio. Impact pathways and theories of change were developed for all four thematic areas and for the five regional programs in CCAFS, as one step in refining the program portfolio. The iterative development of the theory of change and impact pathways for all 90 projects in the portfolio took a considerable amount of effort. Initial meetings were held virtually, for the most part, building on a considerable amount of previous engagement and regional priority-setting. The process was completed in five regional face-to face meetings with key next-users and stakeholders actively participating. These regional workshops were of three-to-four days' duration each, with approximately 50–60 scientists and partners in each workshop and a total cost of approximately US$500,000 (excluding staff time). In these workshops, as noted above, the theory of change development and facilitation process, along with guidance documentation, were revised to make them leaner, more contextualized, less time consuming and easier to implement (Schuetz et al., 2014a). This was important for maintaining buy-in into the process of using theories of change as a management tool across the entire project portfolio (some US$55 million per annum and 90 projects). The workshops resulted in several outputs: impact pathways for many of the projects, key partners trained in theory of change development, and a coherent set of outcome targets, as well as workshop documentation and learning notes. It was envisaged that the outputs would help to facilitate changes in people's

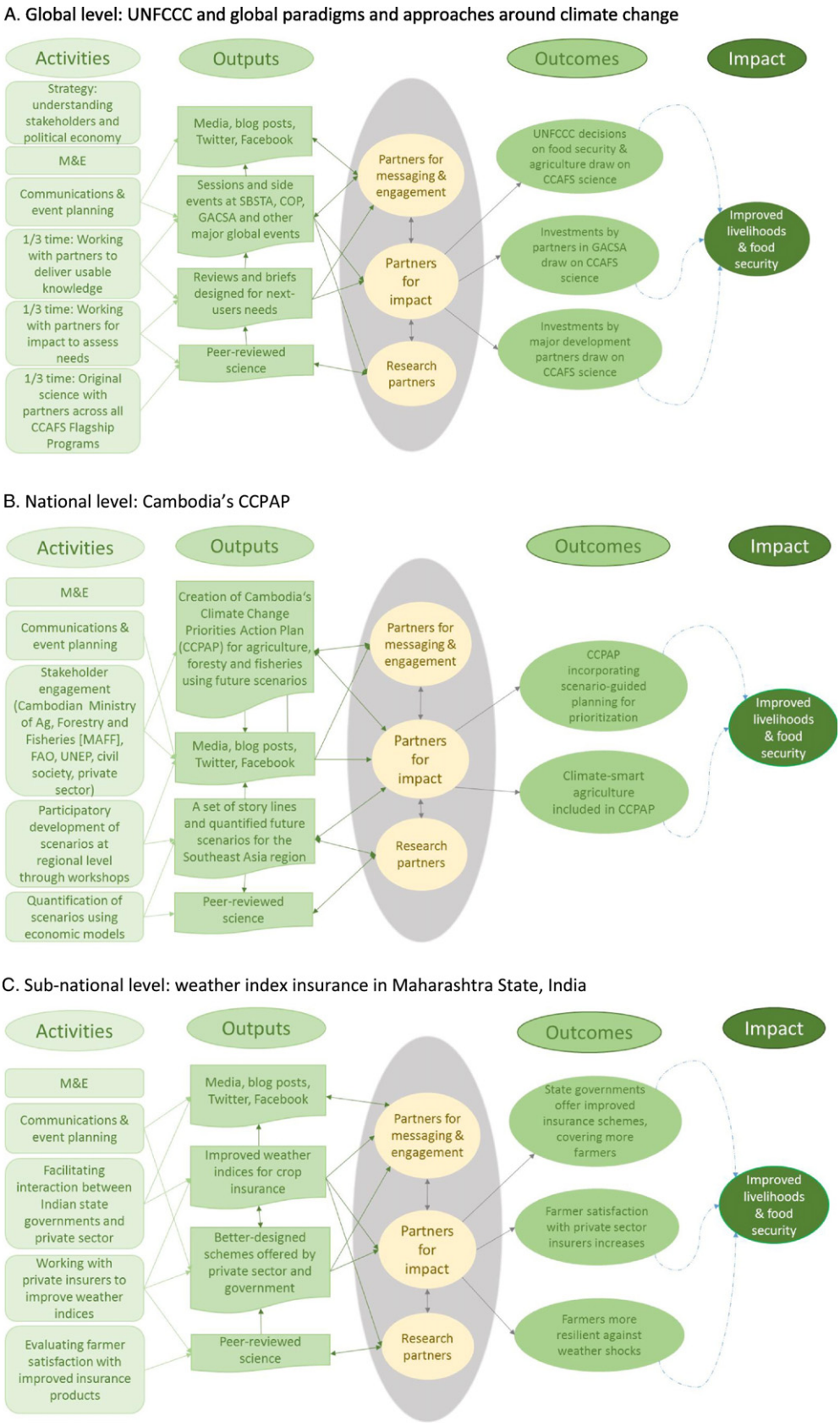

Fig. 2. Theories of change: three examples at different levels. Acronyms: CCPAP, Climate Change Priorities Action Plan. COP, Conference of the Parties. GACSA, Global Alliance on Climate-Smart Agriculture. M&E, Monitoring and Evaluation. SBSTA, Subsidiary Body for Scientific and Technological Advice. UNFCCC, United Nations Framework Convention on Climate Change. A. Global level: UNFCCC and global paradigms and approaches around climate change. B. National level: Cambodia's CCPAP. C. Sub-national level: weather index insurance in Maharashtra State, India.

practice, such as working towards implementing more effective AR4D and proactively changing organisational norms.

Three examples of project theories of change are shown in Fig. 2. In Fig. 2A, an approach is shown for bridging between science and policy in the climate and agriculture space at the global level, to contribute to outcomes for global policies and investments that in turn achieve positive impacts on smallholder livelihoods and food security under climate change. Activities in this theory of change emphasize partnerships, putting a large proportion of effort into understanding and responding to next-users' needs. The political economy of climate change and food security is highly complex at the global level, and the theory of change, set out with a wide range of partners in the project design phase, has helped to navigate this by encouraging a focus on a small number of research outputs and events each year. This has been facilitated by a small group of close partners, which often varies from one year to the next. This global policy engagement work contributed to the inclusion of agriculture and food security in Parties' contribution to the Paris Agreement adopted by the UNFCCC in 2015 at COP21, for example (Vermeulen, 2016). It may be several more years before there is robust evidence as to the achievement of impact as a result of this decision, but as noted above, impact pathways may be very long.

A second example of a theory of change is shown in Fig. 2B, at the national level. A set of regional scenarios was developed through a participatory process for Southeast Asia, and these were quantified with research partners and used in the formulation of the Climate Change Priorities Action Plan (CCPAP) of Cambodia's Ministry of Agriculture, Forestry and Fisheries. The scenarios were used to test the plan, the main purpose of which is to enhance the resilience of the agricultural sector and farmers' livelihoods. The project's theory of change was developed with relevant stakeholders at the same time as the scenarios process was undertaken, to help ensure high relevance and the inclusion of the partners likely to be necessary for success. This work has the potential to benefit the entire population in different ways in the coming years - over 15 million people in Cambodia, 12 million of whom live in rural areas (Vervoort et al., 2015). As for many AR4D activities, participatory development and engagement processes are key for attaining outcomes. Without stakeholder buy-in from the very beginning, research activity outputs may have no traction among partners and intended next users.

A third example, at the sub-national level, is shown in Fig. 2C, focusing on work in one state of India to improve weather-based index insurance in several states. By providing technical assistance to insurance companies to improve the indices used by the insurance industry and also facilitating interaction between state government and the private sector, the aim is to increase the satisfaction of farmers using crop insurance. With better satisfaction rates, more farmers will be encouraged to make use of insurance products, and it is envisaged that this will increase their resiliency in the face of climate variability and extremes. As in the other examples above, the theory of change for this work was co-developed early in the project cycle in an effort to ensure relevance and buy-in from all key stakeholders. After three seasons of A4RD, more than 1 million farmers in Maharashtra state are now being reached with improved insurance products to help them cope with climate risk in their soybean, rice, cotton and pearl millet crops (Aggarwal and Shirsath, 2015).

3.4. Monitoring, evaluation, learning and impact assessment

A monitoring, evaluation, learning and impact assessment strategy was developed to support the new approach in a comprehensive manner (Schuetz et al., 2014b). This strategy was developed to help promote an "evaluative culture" within the program. It includes a conceptual framework, guided by overall program principles for partnership, engagement and communications in a modular way, so that the demands can be met of the program as a whole, its projects, and the wider research system within which CCAFS is embedded. Some elements of the strategy are prescribed by program governance bodies, including the carrying out of baselines, independent impact assessments, and periodic external evaluations, for example.

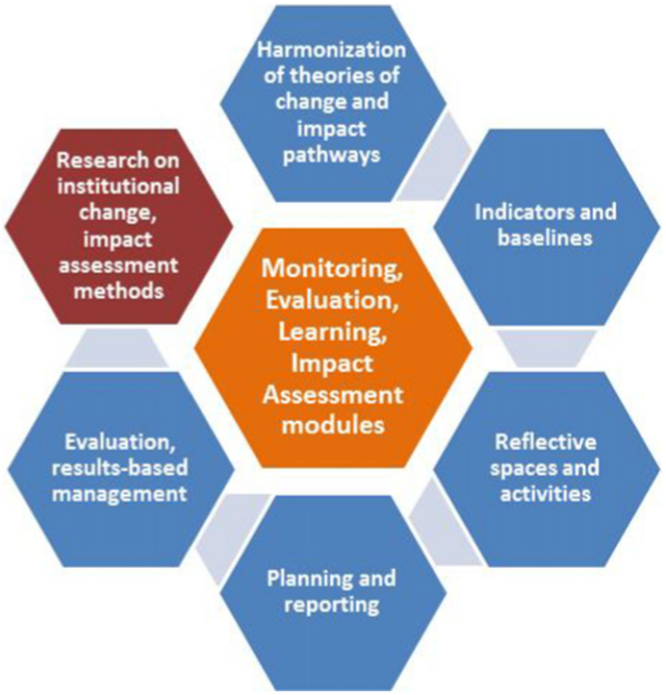

Fig. 3. Elements of monitoring, evaluation, learning and impact assessment. (Adapted from Schuetz et al., 2016.)

Several elements are needed to implement the strategy (Fig. 3). Theories of change and impact pathways have to be harmonized so that all projects are contributing to program targets. With appropriate theories of change defined, indicators and baselines are needed so that the assumptions underlying them can be continually tested and projects' contributions checked for alignment and plausibility. In its first three years, CCAFS undertook a set of baseline studies at key sites in all five regions (Förch et al., 2014), so that behaviour and practice changes of farmers and other decision-makers could be evaluated through time. Not all the indicators needed for all outcome targets are covered in these baselines, so projects themselves are responsible for conducting the additional baselines needed to monitor progress over time related to their specific research activities. Several elements around self-reflection are needed, if adaptive management that provides for flexibility and corrective action is to be implemented. Change often happens not as anticipated, and appropriate mechanisms are critical for allowing us to make well-documented and well-justified adjustments in response to the insights gained through our work. A key component is an ICT-supported program and project management processes in the form of an online platform, building on the online community of practice mentioned in Section 3.1 above, used by project teams to plan activities, report on them, and monitor progress against outcome target indicators. This platform is accompanied by a "support pack" that provides practical guidance and tools for quantitative and qualitative monitoring. Project evaluation and synthesis are carried out in the wake of project reporting to simplify reporting to funding agencies and facilitate learning and knowledge brokerage across the program portfolio and beyond. Evaluation criteria include traditional output-focused criteria, as well as progress towards outcomes, partnership and learning. Incentive mechanisms are being introduced, recognising that these do not always have to relate to budgetary bonuses. A final element encompasses researchable issues that some projects may contribute to, including issues around institutional change, incentives, and social learning, for example.

4. Implications for policy, practice and research

Working with theories of change has major implications in several dimensions. In relation to monitoring, evaluation, learning and impact assessment, it implies a shift in focus to contribution rather than attribution, to acknowledge the role and inputs of partners and other actors both in achieving outcomes and in providing evidence for those outcomes. Building in triple-loop learning (Kristjanson et al., 2014) can make a major contribution to reflection and to supporting adaptive management, so that project teams can better deal with uncertainty. At the same time, not everything can be measured; this highlights the need for narratives that can complement and support quantitative information. Bringing both qualitative and quantitative information to bear remains a substantial challenge (Vogel, 2012), and impact assessment methodology needs to evolve considerably to address social processes and outcomes in robust ways; it is not yet up to the task (Befani et al., 2016).

Project implementation in CCAFS aspires to a "three-thirds principle" in relation to engagement effort: a third working with next-users to build relationships and define their needs from research, a third on the research itself, and a third on enhancing next-users' capacity to improve the uptake of research outputs (Fullana i Palmer et al., 2011; Vermeulen and Campbell, 2015). This does not necessarily translate into a third for each of these three elements in relation to financial resources, as engagement processes themselves may not be that costly, though they may be time-consuming. As part of creating a program enabling environment, embracing this three-thirds principle facilitates investment into solid science, critical partnerships, ownership and buy-in by partners, and capacity enhancement at all levels both internally and externally. Embracing the three-thirds principle also implies different budgeting and funding structures, so that appropriate levels of resources are allocated to capacity building, communications and engagement with the wide range of different partners likely to be needed to produce outcomes. These elements need to be budgeted for explicitly within a project life-cycle, rather than as an after-thought and left to others or outsourced. At the same time, there is still much work to be done on how to monitor outcomes effectively, how to evaluate the real share of contribution towards the observed change, and how to assess value for money. Similarly, delivery of outcomes, especially at scale, may take time for AR4D programs. Longer funding cycles could be expected to facilitate this considerably, as well as explicit recognition that research does not start from scratch, allowing outcomes from previous investment cycles to be reported on.

As noted above, the processes described in Section 3 have been documented in reports and learning briefs (see Annex 1), which included participant surveys and self-reflection activities. On the basis of this information, below we summarise the CCAFS experience in implementing an AR4D approach based on theory of change in relation to four overarching elements: flexibility, learning, effectiveness, and incentives.

4.1. Flexibility

The need for flexibility is key. Rigid application of a specific approach most likely will not work. Early interaction with users led to a considerable simplification of the CCAFS process (Section 3.2), to arrive at something that was not seen as overly burdensome to engage with. In designing and implementing systems and solutions, this may well involve abandoning the goal of best practice for a goal of "good enough". The CCAFS experience involved several false starts and considerable frustration before implementing a lean and simple model that most users felt they were able to buy into. At the same time, a flexible framework is needed to allow aggregation of output, outcomes and targets across the different program units (projects, research areas, regions).

4.2. Learning

Robust knowledge needs to be generated that can feed into development policy and investment decision making, and this in turn requires a cumulative and broad-based approach in choosing evaluation and impact assessment methods at different levels (Maredia, 2009). An approach based on theory of change supports adaptive management: because the former is based on learning processes, it allows mid-course corrections to be made (including modifying the assumptions and hypotheses that originally helped to define the theory of change), and so facilitates dealing with uncertainty and emerging priorities and opportunities. The ICT process supported through the online platform for project planning, reporting and evaluation procedures has proved to be a good vehicle for learning as well as project management. The platform is far from perfect, but it does foster the inclusive involvement of as wide a range of stakeholders as possible in project planning, implementation and reporting. There are substantial costs involved (either using commercial products or developing something from scratch over many months), but in CCAFS's case, development and maintenance costs are being shared among several programs.

4.3. Effectiveness

The necessity of providing value for money has to be embraced. Many funding agencies now require that grantees demonstrate value for money. "The purpose of the VfM [Value for Money] drive is to develop a better understanding (and better articulation) of costs and results so that we can make more informed, evidence-based choices" (DFID, 2011). Some have critiqued the whole notion of payment by results as applied to development and AR4D on the basis that it provides perverse incentives that actually diminishes cost-effectiveness (for example, see Chambers, 2014). As noted above, there is much work still to do on appropriate measurement mechanisms, but this does not diminish the need to demonstrate accountability and results. The jury is still out on the question of whether theory-of-change-based AR4D is more effective in leading to outcomes and impact compared with other approaches; nevertheless, the conceptual grounding of theory of change in iterative learning processes, as noted in Section 2 above (Douthwaite et al., 2003), provides grounds for optimism. The portfolio of projects within CCAFS is continuing to shift in response to newly-formulated theories of change and impact pathways for the various thematic areas, including the expansion of activities around nutrition scenarios and modelling to contribute to targets on food and nutrition security under climate change, for instance. Similarly, the number of non-research partners that CCAFS interacts with continues to increase, in response to the need for engagement with next- and end-users of research outputs; currently, some 35% of CCAFS's strategic partners are in this category (CCAFS, 2016). Within CGIAR, a similar theory-of-change approach was piloted over a ten-year period (2004–2013) by the Challenge Program on Water and Food. An external review of that program placed their work at the leading edge of global research, and this research resulted in developmental outcomes although limited impact at scale by the time the review was undertaken (Hall et al., 2014).

4.4. Incentives

Research is often curiosity-driven, and traditional indicators of success centre on peer-reviewed publications in high-profile academic journals. In today's highly competitive research environment another crucial success factor relates to fundraising: the ability to write and win competitive research proposals. Neither of these motivations for research is guaranteed to deliver development outcomes. For that, new investments of time and effort may be needed to identify and work with non-traditional partners to promote behavioural change in shared theories of change. This suggests the need for AR4D organisations to expand their incentive system to reward different types of excellence in

addition to great science, such as strategic team and partnership building, engagement, communications and capacity development, for example. The development of theories of change can lead all participants, whatever their skills, to give thought to what lies between solid science, great interventions, and their positive developmental impact, by allowing teams to monitor, reflect, evaluate and learn.

5. Conclusions

Strong incentives from funding agencies for a move towards outcome-oriented research programs are having considerable impact on the way in which agricultural research is conceived, planned, implemented and evaluated. A key requirement for such work is flexibility - the flexibility to adjust so that the outcome orientation works as a support mechanism and enabler rather than a one-size-fits-all straitjacket without space for innovation, serendipity and creativity. The shift to an AR4D approach based on theory of change is fostering real transition in the international agricultural research community, much of it for the better in our view. However, it also comes with considerable challenges. Defining the necessary adjustments, and developing new processes and mechanisms, needs time and resources, which are often grossly underestimated and for which planning is often inadequate. Some of these challenges arise because of the nature of research: the results are not known from the start, in contrast to engineering, for example, where the results are much less uncertain. A second challenge lies in striving to balance the need to do great science with the need for impact delivery at scale. A third challenge lies in generating an evidence base that can rigorously address whether and how theory-of-change-based approaches lead to efficiency and effectiveness gains in AR4D compared with other approaches. An evaluation of the outcomes and impacts of CCAFS's work is planned for 2020–2021, building in part on revisiting the baselines carried out in the five target regions in 2011–2013 (Förch et al., 2014). In general, this kind of evidence generation will almost certainly involve multi- and trans-disciplinary research that mixes quantitative approaches to measure outcome variables with qualitative approaches that establish the causal mechanisms involved, however difficult this may be in relation to social processes and human behaviour (Carr, 2013). Above all, we need to avoid the focus on outcomes being seen as disadvantageous to science, and development being seen as in competition with the science. Rather, they need to be seen as complementary, enabling, and ultimately liberating.

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Annex 1
Published reports and learning briefs related to the CCAFS theory of change approach.

	Title	Permanent web link
1	Jost CC, Sebastian L, Kristjanson P, Förch W 2014. Lessons in theory of change: CCAFS Southeast Asia Research for Development Workshop. CCSL Learning Brief No. 8. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).	http://hdl.handle.net/10568/42447
2	Jost CC, Kristjanson P, Vervoort J, Alvarez S, Ferdous N, Förch W. 2014. Lessons in theory of change: monitoring, learning and evaluating Knowledge to Action. CCSL Learning Brief No. 9. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)	http://hdl.handle.net/10568/42446
3	Alvarez S, Jost C, Schuetz T, Förch W, Schubert C, Kristjanson P. 2014. Lessons in Theory of Change from the Introductory Training on Theories of Change, Impact Pathways and Monitoring & Evaluation. CCSL Learning Brief No. 10. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)	http://hdl.handle.net/10568/52992
4	Schuetz T, Förch W, Thornton P, Wollenberg L, Hansen J, Jarvis A, Coffey K, Bonila-Findji O, Loboguerrero Rodriguez AM, Martínez Barón D, Aggarwal P, Sebastian L, Zougmoré R, Kinyangi J, Vermeulen S, Radeny M, Moussa A, Sajise A, Khatri-Chhetri A, Richards M, Jost C, Jay A. 2014. Learning Brief: Lessons in Theory of Change from a Series of Regional Planning Workshops. Learning Brief No 11. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)	http://hdl.handle.net/10568/52990
5	Schuetz T, Förch W, Schubert C, Thornton P, Cramer L. 2014. Lessons and Insights from CCAFS Results-Based Management Trial. Learning Brief No 12. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen: Denmark	http://hdl.handle.net/10568/56629
6	Jost C, Kristjanson P, Ferdous N. 2015. Lessons in Theory of Change: Gender and Inclusion. Learning Brief No 14. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).	http://hdl.handle.net/10568/61900
7	Schuetz T, Förch W, Thornton PK 2015. CCAFS reporting and evaluation in a results-based management framework. Learning Brief 15. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)	http://hdl.handle.net/10568/67362
8	Förch W, Schuetz T, Abreu D, Tobon H, Thornton P. 2016. Building an online platform in support of outcome-focused results-based program management. CCSL Learning Brief No. 16. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).	http://hdl.handle.net/10568/69497

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